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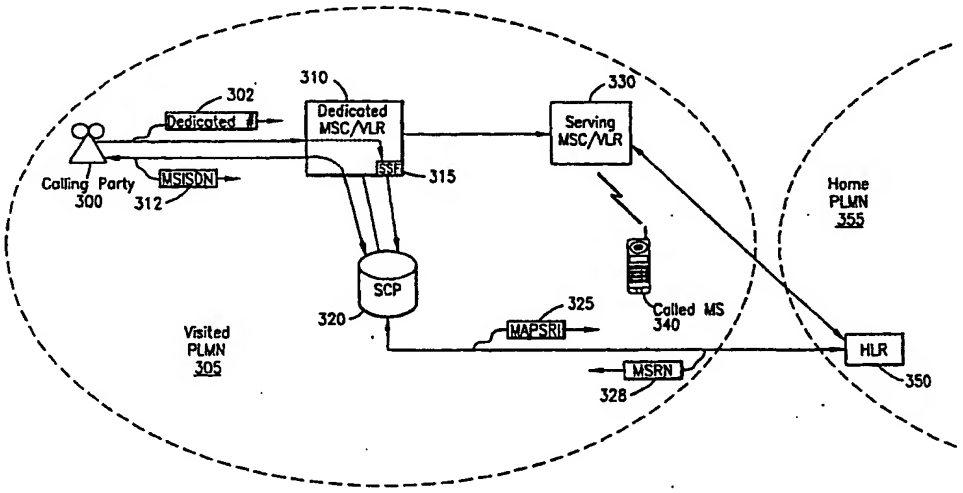

(57) Abstract

A telecommunications system and method is disclosed for providing an Intelligent Network (IN) solution for completing a call to a roaming mobile subscriber without routing the call through the roamer's home Public Land Mobile Network (PLMN). When a mobile subscriber is roaming in a visited PLMN, the visited network can provide a dedicated number associated with a dedicated Mobile Switching Center (MSC) that local calling party's can dial to reach the mobile subscriber without routing through the home PLMN. When a local calling party dials the dedicated number, the call is routed to the dedicated MSC, which triggers the IN. The call is then routed to an intelligent node to collect the actual directory number for the called mobile subscriber from the calling party, verify that the roaming called mobile subscriber is within the visited PLMN and complete the call via the dedicated MSC.

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SYSTEM AND METHOD FOR CALL COMPLETION TO A ROAMER WITHOUT ROUTING THROUGH THE HOME NETWORK

BACKGROUND OF THE PRESENT INVENTION

Field of the Invention

The present invention relates generally to telecommunications systems and methods for routing incoming calls to a mobile terminal within a cellular network, and specifically to routing incoming calls to a roaming mobile terminal without routing through the mobile terminal's home public land mobile network.

Background and Objects of the Present Invention

In modern telecommunications networks, signaling constitutes the distinct control infrastructure that enables provision of all other services. It can be defined as the system that enables stored program control exchanges, network databases, and other "intelligent" nodes of the network to exchange: (a) messages related to call setup, supervision, and tear-down; (b) information needed for distributed applications processing (inter-process query/response); and (c) network management information.

In addition, the Intelligent Network (IN) and the Advanced Intelligent Network (AIN) have made possible the transfer of all types of information through the telephone network without special circuits or long installation cycles. The IN consists of a series of intelligent nodes, each capable of processing at various levels, and each capable of communicating with one another over data links. The IN relies on the Signaling System #7 (SS7) network, which provides the basic infrastructure needed for the various signaling points in the IN. SS7 relies on Common Channel Signaling, which uses a digital facility, but places the signaling information in a time slot or channel separate from the voice and data it is related to. This allows signaling information to be consolidated and sent through its own network apart from the voice network.

The various signaling points in the IN both perform message discrimination (read the address and determine if the message is for that node), and route messages

to other signaling points. The basic three types of signaling points are: (1) Service Switching Points (SSPs); (2) Signal Transfer Points (STPs); and (3) Service Control Points (SCPs), each of which are described in more detail hereinafter.

With reference now to FIGURE 1 of the drawings, the many Service Switching Points (SSPs) 100 serve as the local exchanges in a telephone network 90, a portion of which is shown in FIGURE 1. The STP 110 serves as a router, and switches messages received from a particular SSP 100 through the network 90 to their appropriate destinations (another SSP 100). As is also understood in the art, the STP 110 receives messages in packet form from the SSPs 100. These packets are either related to call connections or database queries. If the packet is a request to connect a call, the message must be forwarded to a destination end office (another SSP 100), where the call will be terminated.

If, however, the message is a database query seeking additional information, the destination will be a database. Database access is provided through the Service Control Point (SCP) 120, which does not store the information, but acts as an interface to a computer that houses the requested information.

One type of network which in many cases relies on SS7 signaling is the cellular network. Cellular telecommunications is one of the fastest growing and most demanding telecommunications applications ever. Today it represents a large and continuously increasing percentage of all new telephone subscriptions around the world. A standardization group, European Telecommunications Standards Institute (ETSI), was established in 1982 to formulate the specifications for the Global System for Mobile Communication (GSM) digital mobile cellular radio system.

With reference now to FIGURE 2 of the drawings, there is illustrated a GSM Public Land Mobile Network (PLMN), such as wireless network 10, which in turn is composed of a plurality of areas 12, each with a Mobile Services Center (MSC) 14 and an integrated Visitor Location Register (VLR) 16 therein. The MSC/VLR areas 12, in turn, include a plurality of Location Areas (LA) 18, which are defined as that part of a given MSC/VLR area 12 in which a mobile station (MS) 20 may move freely without having to send update location information to the MSC/VLR area 12

that controls the LA 18. Each Location Area 12 is divided into a number of cells 22. Mobile Station (MS) 20 is the physical equipment, e.g., a car phone or other portable phone, used by mobile subscribers to communicate with the wireless network 10, each other, and users outside the subscribed network, both wireline and wireless.

The MSC 14 is in communication with at least one Base Station Controller (BSC) 23, which, in turn, is in contact with at least one Base Transceiver Station (BTS) 24. The BTS 24 is the physical equipment, illustrated for simplicity as a radio tower, that provides radio coverage to the geographical part of the cell 22 for which it is responsible. It should be understood that the BSC 23 may be connected to several BTSs 24, and may be implemented as a stand-alone node or integrated with the MSC 14. In either event, the BSC 23 and BTS 24 components, as a whole, are generally referred to as a Base Station System (BSS) 25.

With further reference to FIGURE 2, the PLMN Service Area or wireless network 10 includes a Home Location Register (HLR) 26, which is a database maintaining all subscriber information, e.g., user profiles, current location information, International Mobile Subscriber Identity (IMSI) numbers, and other administrative information. The HLR 26 may be co-located with a given MSC 14, integrated with the MSC 14, or alternatively can service multiple MSCs 14, the latter of which is illustrated in FIGURE 2.

The VLR 16 is a database containing information about all of the Mobile Stations 20 currently located within the MSC/VLR area 12. If an MS 20 roams into a new MSC/VLR area 12, the VLR 16 connected to that MSC 14 will request data about that MS 20 from its home HLR database 26 (simultaneously informing the HLR 26 about the current location of the MS 20). Accordingly, if the user of the MS 20 then wants to make a call, the local VLR 16 will have the requisite identification information without having to reinterrogate the home HLR 26. In the aforedescribed manner, the VLR and HLR databases 16 and 26, respectively, contain various subscriber information associated with a given MS 20.

Currently, many network providers are implementing a feature called "Call Completion to a Roamer Without Routing Through the Roamers Home PLMN".

Each PLMN 10 that supports the "Call Completion to a Roamer Without Routing Through the Roamers Home PLMN" feature provides a specific telephone number associated with the roaming MS 20 that a calling subscriber can dial to route the call directly to the MSC 14 serving the roaming MS 20 in the visited PLMN 10. The roaming subscriber within the visiting PLMN 10 can then inform all the potential calling subscribers that are located within the visited area 10 of the dedicated number, in order to route incoming calls from those subscribers directly to the serving MSC 14, instead of first through the subscribers home PLMN 10.

However, this feature can only be utilized by a roaming subscriber if the visited PLMN 10 supports this feature, e.g., the feature is implemented in the serving MSC 14. Thus, a roaming subscriber will have to incur long-distance charges for routing through the roamer's home PLMN 10 if the visited PLMN 10 does not support this feature.

It is, therefore, an object of the present invention to provide an Intelligent Network implementation of the "Call Completion to a Roamer Without Routing Through the Roamers Home PLMN" feature.

SUMMARY OF THE INVENTION

The present invention is directed to telecommunications systems and methods for providing an IN solution for completing a call to a roaming subscriber without routing the call through the roamer's home PLMN. When a mobile subscriber is roaming in a visited PLMN, the roaming subscriber can ask the network provider for a dedicated number that a local calling party can dial to reach the mobile subscriber without the mobile subscriber incurring long-distance charges. This dedicated telephone number is a number for a dedicated MSC within the visited PLMN. When a calling party dials the dedicated number, the call is routed to the dedicated MSC, which then routes the call to a service switching function (SSF) within the MSC to trigger the IN. The SSF then routes the call to an SCP, which then collects the actual directory number for the called mobile terminal from the calling party. The SCP then either requests routing instructions from the HLR and completes the call via the

dedicated MSC if the mobile terminal is within the visited PLMN, or the SCP only screens the call to ensure that the called mobile subscriber is located within the visited PLMN and then the call is completed via the dedicated MSC and a Gateway MSC (GMSC).

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed inventions will be described with reference to the accompanying drawings, which show important sample embodiments of the invention and which are incorporated in the specification hereof by reference, wherein:

FIGURE 1 is a block diagram illustrating some of the basic components used in an Intelligent Network or an Advanced Intelligent Network for signal switching;

FIGURE 2 is a block diagram of a conventional terrestrially-based wireless telecommunications system;

FIGURE 3 illustrates one embodiment of an Intelligent Network solution to completing a call to a roaming mobile subscriber without routing the call through the roamer's home Public Land Mobile Network in accordance with preferred embodiments of the present invention; and

FIGURE 4 shows another embodiment of the present invention in which a call is completed to a roaming mobile subscriber without routing the call through the roamer's home PLMN.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EXEMPLARY EMBODIMENTS

The numerous innovative teachings of the present application will be described with particular reference to the presently preferred exemplary embodiments. However, it should be understood that this class of embodiments provides only a few examples of the many advantageous uses of the innovative teachings herein. In general, statements made in the specification of the present application do not necessarily delimit any of the various claimed inventions. Moreover, some statements may apply to some inventive features but not to others.

With reference now to FIGURE 3 of the drawings, an Intelligent Network (IN) solution for completing a call to a roaming mobile subscriber without routing the call through the roamer's home Public Land Mobile Network (PLMN) 355 can be achieved by assigning a dedicated telephone number 302 associated with a dedicated Mobile Switching Center/Visitor Location Register (MSC/VLR) 310 within a visited PLMN 305 and informing the roaming mobile subscriber of the dedicated number 302. The roaming mobile subscriber can then give the dedicated number 302 to potential calling party's 300 (other mobile subscribers or wireline subscribers, the latter being illustrated), which are located within the area encompassed by the visited PLMN 305 in order to avoid long-distance charges normally associated with routing calls through the roamer's home PLMN 355.

Thereafter, when a calling party 300 dials the dedicated number 302, the call is routed to the dedicated MSC/VLR 310 within the visited PLMN 305. The dedicated MSC/VLR 310 can then route the call to a service switching function (SSF) 315 within the dedicated MSC/VLR 310, which triggers the IN. The SSF 315 can then route the call to a Service Control Point (SCP) 320 within the IN, which has an interface to the dedicated MSC/VLR 310. The SCP 320 then sends a second dial tone or announcement to the calling party 300 to collect the Mobile Station Integrated Services Digital Network Number (MSISDN) 312, e.g., the directory number of a Mobile Station (MS) 340 associated with the called mobile subscriber, from the calling subscriber 300.

Once the SCP 320 receives the MSISDN 312, the SCP 320 can request routing information for the called MS 340 associated with the MSISDN 312 by sending a MAP SRI (Send_Routing_Information) message 325 to a Home Location Register (HLR) 350 that stores the subscriber data for that called MS 340. The HLR 350 determines which MSC/VLR 330 that the called MS 340 is registered with and obtains a Mobile Station Roaming Number (MSRN) 328 from that serving MSC/VLR 330. The HLR 350 then forwards the MSRN 328 to the SCP 320, which can then route the call to the serving MSC/VLR 330 for completion of the call.

Prior to routing the call to the serving MSC/VLR 330, the SCP 320 first confirms that the MSRN 328 is within the visited PLMN 305, e.g., the called MS 340 is registered with an MSC/VLR 330 within the visited PLMN 305, and optionally confirms whether the called mobile subscriber allows local call completion, which can be determined by checking the subscriber data associated with the called MS 340 stored in the HLR 350. For example, the visited PLMN 305 and/or the home PLMN 355 may require customers to subscribe to a local call feature in order to utilize this feature while roaming. This prevents unauthorized use of the local dedicated number 302 by parties who have not paid for the feature.

Once the SCP 320 confirms the location of the MS 340 within the visited PLMN 305 and that the called MS 340 allows local call completion, the SCP 320 can then set up the call to the called MS 340 using the MSRN 328. If the called MS 340 is within the area served by the dedicated MSC/VLR 310, the SCP 320 routes the call back to the dedicated MSC/VLR 310 for completion of the call. However, if the called MS 340 is within an area served by a different MSC/VLR 330, as illustrated in FIGURE 3, the SCP 320 routes the call to the serving MSC/VLR 330, via the dedicated MSC/VLR 310, to complete the call.

If, however, the called MS 340 is not registered within the visited PLMN 305, the SCP 320 can then set up the call normally, e.g., the SCP 320 can route the call along with the MSISDN 312 back to the called MS's home PLMN 355, which can then set up the call. Alternatively, the SCP 320 can provide the option to the calling party 300 to either complete the call normally or disconnect. In another alternative embodiment, the SCP 320 can provide a message to the calling party 300 indicating that the call cannot be completed locally and instructing the calling party 300 to hang up and dial the MSISDN 312 directly for the called MS 340.

In an alternative embodiment, as shown in FIGURE 4 of the drawings, instead of the SCP 320 obtaining the MSRN 328 for the called MS 340, the SCP 320 can instead only screen the call to determine whether the called MS 340 is within the visited PLMN 305. As described above, once the call is routed to the SCP 320 from the SSF 315, the SCP 320 can send a second dial tone or announcement to the calling

party 300 to collect the MSISDN 312 from the calling subscriber 300. However, the SCP 320 then only confirms that the called MS 340 is within the local service area and that the called mobile subscriber has subscribed to this feature (if the visited PLMN 305 or home PLMN 355 requires customers to pay for the feature) by sending an INAP Retrieve message 322 to the HLR 350 to fetch the status and the location of the called MS 340, e.g., the HLR 350 sends back an MSC identity 326, instead of the MSRN 328.

The SCP 320 can then verify that the MSC/VLR 330 serving the area that the called MS 340 is located in is within the visited PLMN 305. If the called MS 340 is registered within the visited PLMN 305, the SCP 320 can then route the call along with the MSISDN 312 back to the dedicated MSC/VLR 310 to complete the call to the roaming called MS 340 normally. The call can be completed to the called MS 340 normally by the dedicated MSC/VLR 310 routing the call to a Gateway MSC (GMSC) 360 within the visited PLMN 305. The GMSC 360 can then complete the call as any other mobile terminating call by obtaining the MSRN 328 from the HLR 350 and routing the call to the serving MSC/VLR 330 to complete the call.

As will be recognized by those skilled in the art, the innovative concepts described in the present application can be modified and varied over a wide range of applications. Accordingly, the scope of patented subject matter should not be limited to any of the specific exemplary teachings discussed.

For example, it should be understood that the IN solution for completing a call to a roaming mobile subscriber without routing the call through the roamer's home PLMN can be applied to any cellular network, including, but not limited to the GSM network, the Personal Communications System (PCS) 1900 network, the AMPS network and the D-AMPS network.

WHAT IS CLAIMED IS:

1. A telecommunications system for completing a call to a roaming mobile terminal without routing the call through a home Public Land Mobile Network associated with said roaming mobile terminal, said telecommunications system comprising:

a dedicated mobile switching center located within a visited Public Land Mobile Network, said dedicated mobile switching center having a dedicated number associated therewith, said call being originated by a calling party located within said visited Public Land Mobile Network dialing said dedicated number, said call being routed to said dedicated mobile switching center;

an intelligent node connected to said dedicated mobile switching center, said call being routed from said dedicated mobile switching center to said intelligent node, said intelligent node obtaining a directory number associated with said roaming mobile terminal from said calling party; and

a home location register in communication with said intelligent node, said intelligent node obtaining location information associated with said roaming mobile terminal from said home location register, said intelligent node completing said call to said roaming mobile terminal when said location information is within said visited Public Land Mobile Network.

2. The telecommunications system of Claim 1, wherein said call is routed to a service switching function within said dedicated mobile switching center to trigger routing said call to said intelligent node.

3. The telecommunications system of Claim 1, wherein said intelligent node is a Service Control Point.

4. The telecommunications system of Claim 1, wherein said directory number is a Mobile Station Integrated Services Digital Network number.

5. The telecommunications system of Claim 1, wherein said location information is a Mobile Station Routing Number.

6. The telecommunications system of Claim 5, wherein said intelligent node obtains said Mobile Station Routing Number by sending a Mobile Application Part Send Routing Information (MAP SRI) message to said home location register.

7. The telecommunications system of Claim 5, further comprising a serving mobile switching center in wireless communication with said roaming mobile terminal, said home location register determining said serving mobile switching center using said directory number and obtaining said Mobile Station Routing Number from said serving mobile switching center.

8. The telecommunications system of Claim 7, wherein said intelligent node routes said call to said serving mobile switching center via said dedicated mobile switching center, using said Mobile Station Routing Number, said serving mobile switching center connecting said call to said roaming mobile terminal.

9. The telecommunications system of Claim 7, wherein said serving mobile switching center is said dedicated mobile switching center, said intelligent node routing said call to said dedicated mobile switching center using said Mobile Station Routing Number, said dedicated mobile switching center connecting said call to said roaming mobile terminal.

10. The telecommunications system of Claim 1, wherein said home location register has a local call feature associated with said roaming mobile terminal stored therein, said intelligent node completing said call to said roaming mobile terminal when said local call feature is active.

11. The telecommunications system of Claim 1, wherein said intelligent

node routes said call to said home Public Land Mobile Network for completion of said call to said roaming mobile terminal when said location information is not within said visited Public Land Mobile Network.

12. The telecommunications system of Claim 1, wherein said location information is a mobile switching center identity.

13. The telecommunications system of Claim 12, wherein said intelligent node sends an INAP retrieve message to said home location register to obtain said mobile switching center identity.

14. The telecommunications system of Claim 12, wherein said intelligent node routes said call and said directory number to said dedicated mobile switching center for completion of said call to said roaming mobile terminal.

15. The telecommunications system of Claim 14, wherein said dedicated mobile switching center routes said call to a gateway mobile switching center within said visited Public Land Mobile Network for connecting said call to said roaming mobile terminal.

16. A method for completing a call to a roaming mobile terminal without routing the call through a home Public Land Mobile Network associated with said roaming mobile terminal, said method comprising the steps of:

dialing, by a calling party located within a visited Public Land Mobile Network, a dedicated number associated with a dedicated mobile switching center located within said visited Public Land Mobile Network therewith, said call being routed to said dedicated mobile switching center;

routing, by said dedicated mobile switching center, said call to an intelligent node connected to said dedicated mobile switching center;

obtaining, by said intelligent node, a directory number associated with said

roaming mobile terminal from said calling party;

obtaining, by said intelligent node, location information associated with said roaming mobile terminal from a home location register in communication with to said intelligent node; and

completing, by said intelligent node, said call to said roaming mobile terminal when said location information is within said visited Public Land Mobile Network.

17. The method of Claim 16, further comprising, before said step of routing, the step of:

routing said call to a service switching function within said dedicated mobile switching center to trigger said step of routing said call to said intelligent node.

18. The method of Claim 16, wherein said intelligent node is a Service Control Point.

19. The method of Claim 16, wherein said directory number is a Mobile Station Integrated Services Digital Network number.

20. The method of Claim 16, wherein said location information is a Mobile Station Routing Number.

21. The method of Claim 20, wherein said step of obtaining said Mobile Station Routing Number is performed by said intelligent node sending a MAP SRI message to said home location register.

22. The method of Claim 20, wherein said step of obtaining said Mobile Station Routing Number is performed by said home location register determining a serving mobile switching center in wireless communication with said roaming mobile terminal using said directory number, said home location register obtaining said Mobile Station Routing Number from said serving mobile switching center.

23. The method of Claim 22, wherein said step of completing said call is performed by said intelligent node routing said call to said serving mobile switching center via said dedicated mobile switching center, using said Mobile Station Routing Number, said serving mobile switching center connecting said call to said roaming mobile terminal.

24. The method of Claim 22, wherein said serving mobile switching center is said dedicated mobile switching center, said intelligent node routing said call to said dedicated mobile switching center using said Mobile Station Routing Number, said dedicated mobile switching center connecting said call to said roaming mobile terminal.

25. The method of Claim 16, wherein said home location register has a local call feature associated with said roaming mobile terminal stored therein, said step of completing said call by said intelligent node being performed when said local call feature is active.

26. The method of Claim 16, further comprising, before said step of completing said call, the step of:

routing, by said intelligent node, said call to said home Public Land Mobile Network for completion of said call to said roaming mobile terminal when said location information is not within said visited Public Land Mobile Network.

27. The method of Claim 16, wherein said location information is a mobile switching center identity.

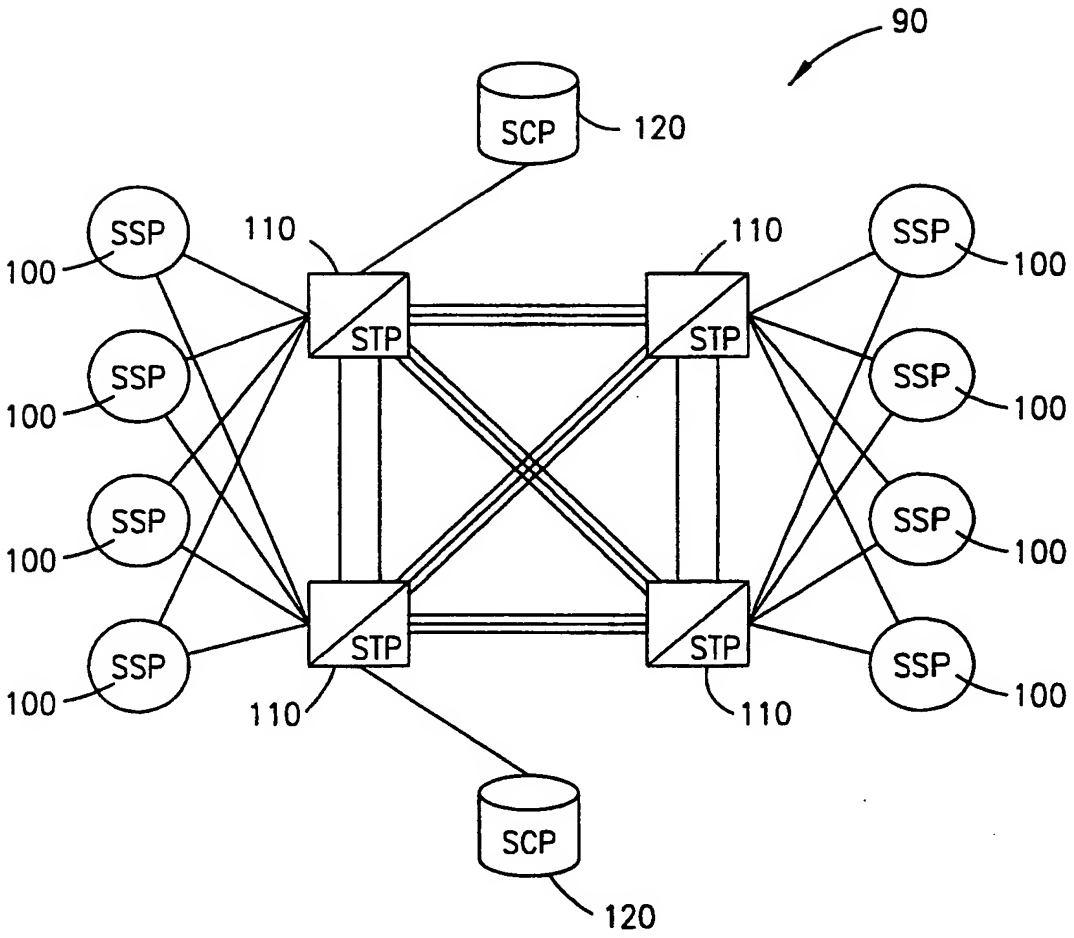
28. The method of Claim 27, wherein said step of obtaining said mobile switching center identity is performed by said intelligent node sending an INAP retrieve message to said home location register.

29. The method of Claim 27, wherein said step of completing said call comprises the step of:

routing, by said intelligent node, said call and said directory number to said dedicated mobile switching center, said dedicated mobile switching center completing said call to said roaming mobile terminal.

30. The method of Claim 29, wherein said step of competing said call comprises, after said step of routing said call and said directory number to said dedicated mobile switching center, the step of:

routing, by said dedicated mobile switching center, said call to a gateway mobile switching center within said visited Public Land Mobile Network, said gateway mobile switching center connecting said call to said roaming mobile terminal.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SCP
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SSP
100
110
STP
SSP
100
SSP
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SSP
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SSP
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FIG. 1

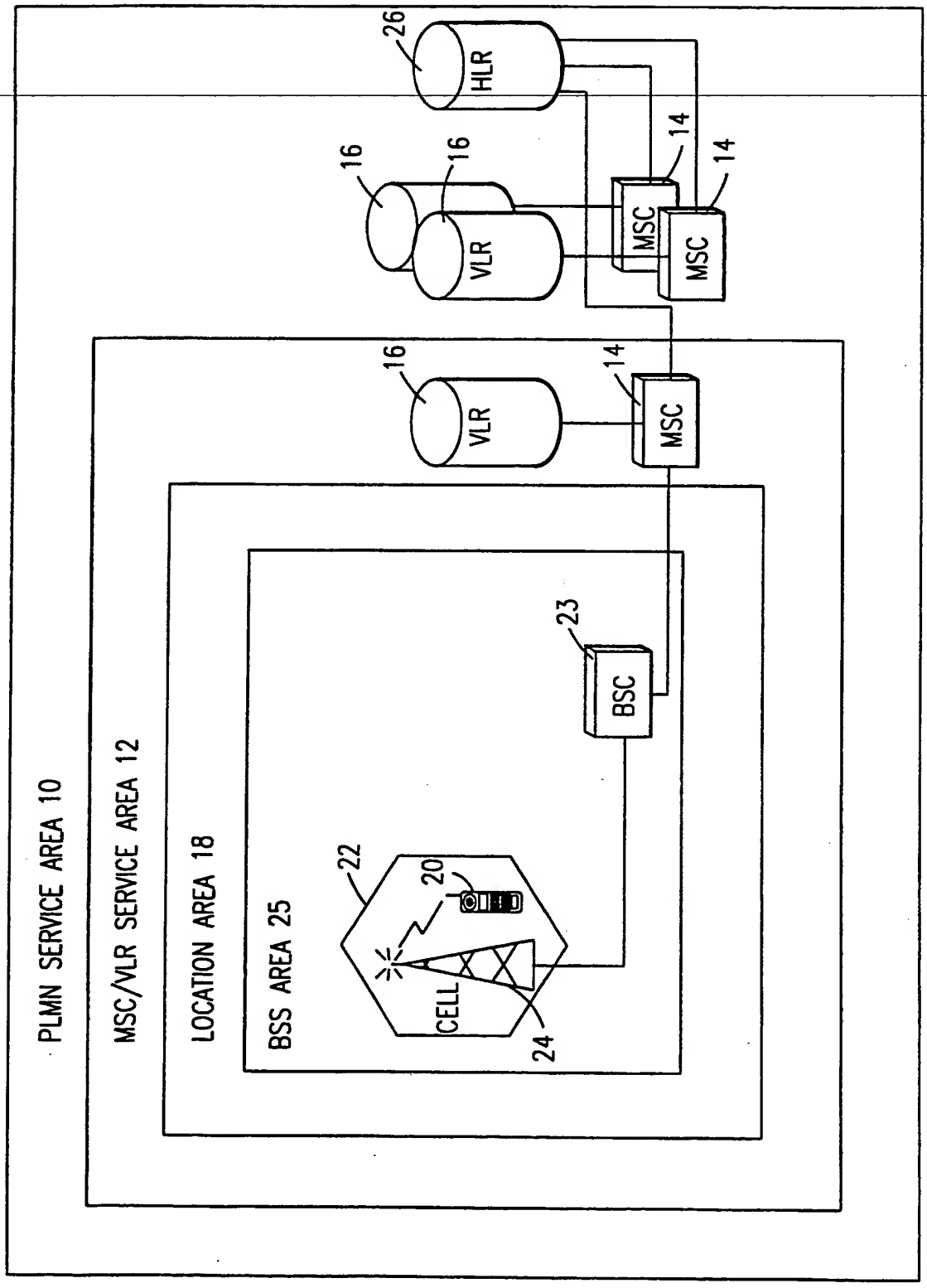
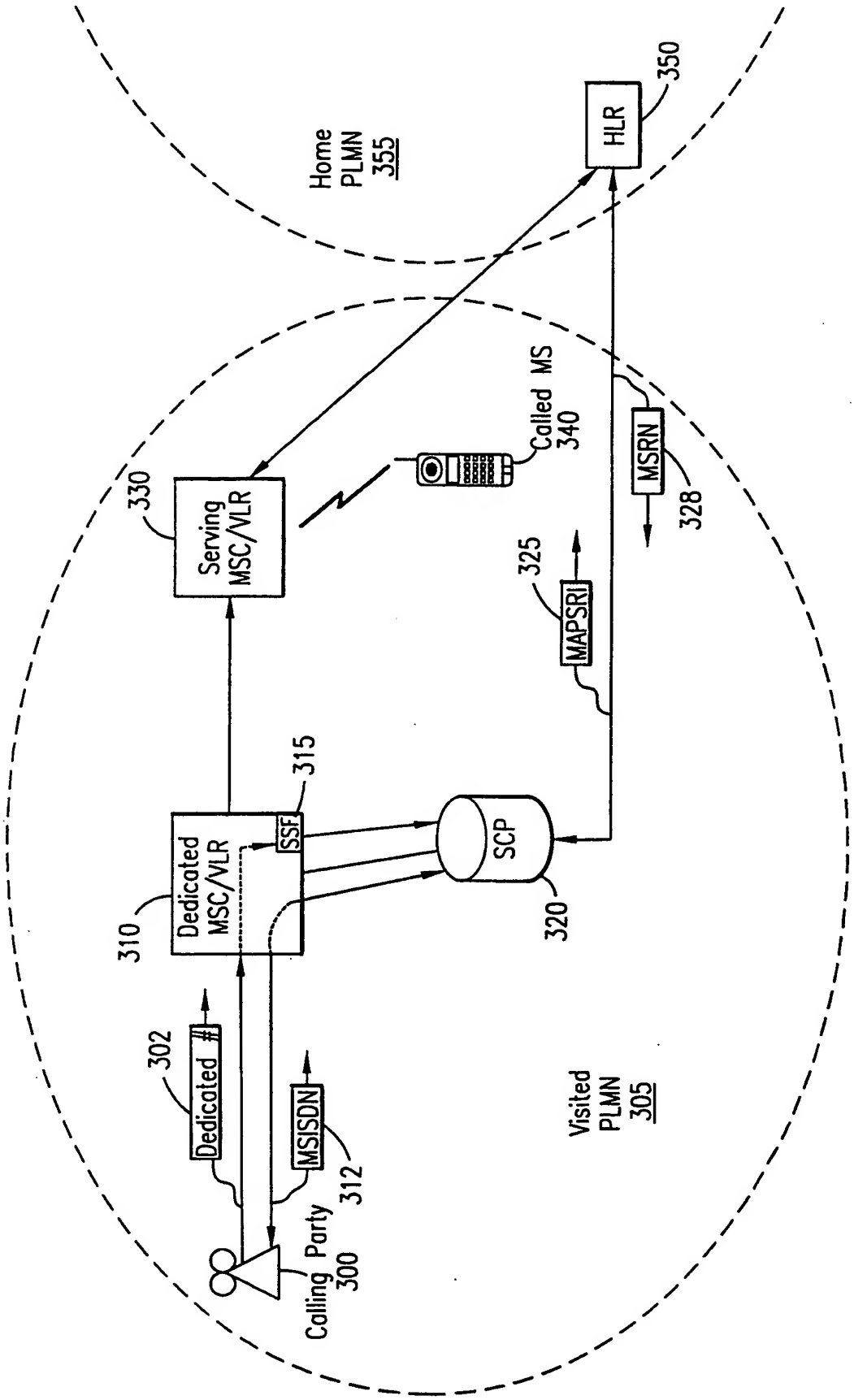

PLMN SERVICE AREA 10
MSC/VLR SERVICE AREA 12
LOCATION AREA 18
BSS AREA 25
CELL
HLR
VLR
MSC
BSC
26
16
14
23
22
20
24

FIG. 2


Home PLMN 355
HLR
350
Called MS 340
MSRN
328
Serving MSC/VLR
330
325
MAPSRI
315
SSF
SCP
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Dedicated MSC/VLR
310
302
Dedicated #
MSISDN
312
Calling Party 300
Visited PLMN 305

FIG. 3

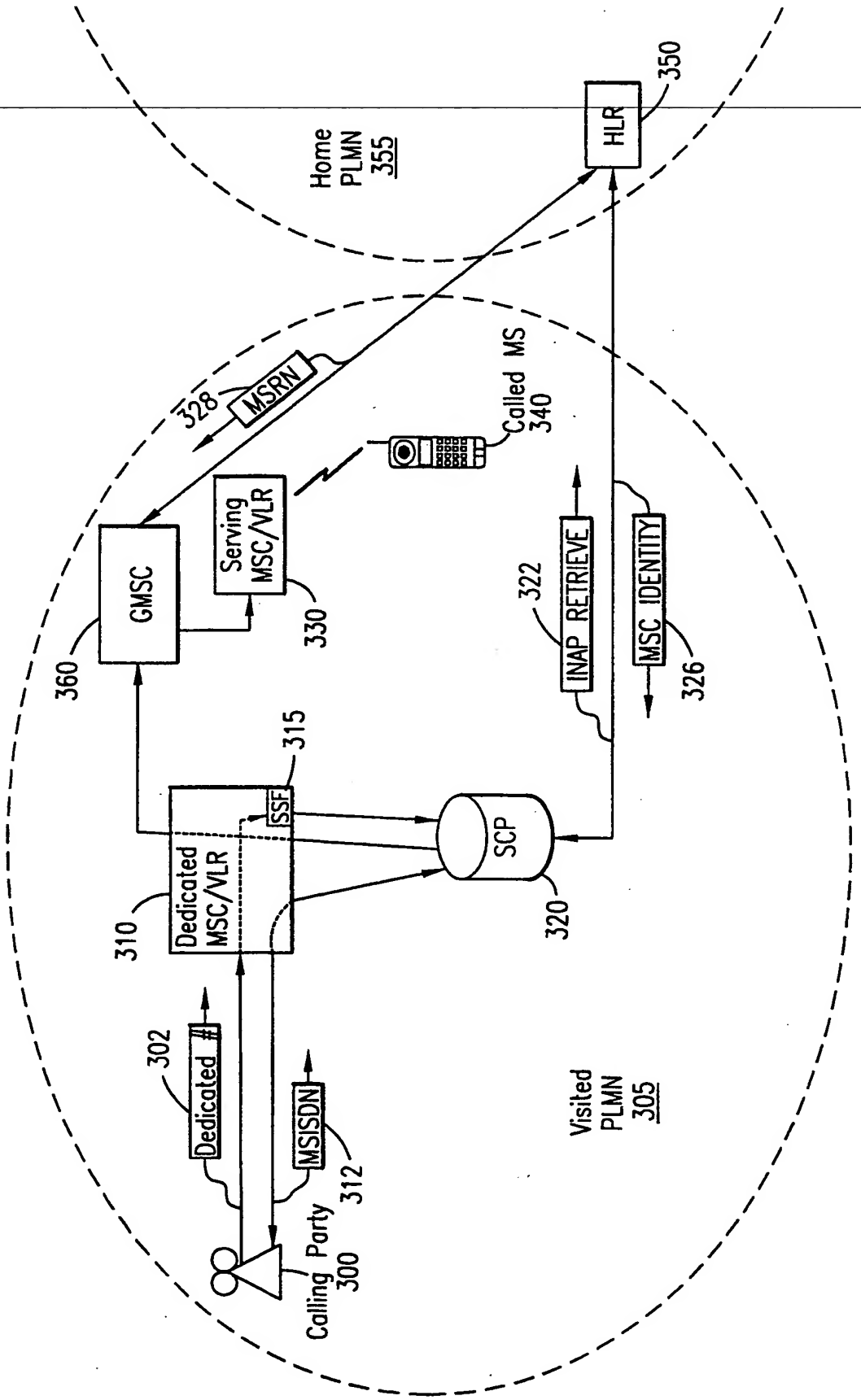
Home PLMN 355
HLR
350
MSRN
328
Called MS 340
GMSC
360
Serving MSC/VLR
330
INAP RETRIEVE
322
MSC IDENTITY
326
SSF
315
Dedicated MSC/VLR
310
SCP
320
Dedicated #
302
MSISDN
312
Calling Party 300
Visited PLMN 305

FIG. 4

INTERNATIONAL SEARCH REPORT

Inte onal Application No
PCT/US 99/19934

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/38 H04Q3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 28930 A (ERICSSON TELEFON AB L M) 2 July 1998 (1998-07-02) page 5, line 1 -page 14, line 25	1-30
A	HARAN D: "DEPLOYING IN SERVICES IN A MOBILE ENVIRONMENT" ANNUAL REVIEW OF COMMUNICATIONS,1997, pages 1043-1049, XP000720970 the whole document	1-30

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 December 1999	14/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Maalismaa, J

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte onal Application No
PCT/US 99/19934

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9828930 A	02-07-1998	US 5913165 A	15-06-1999
		AU 5502398 A	17-07-1998